

## Ka-Band Klystron Amplifier for CUBESATs, Phase II

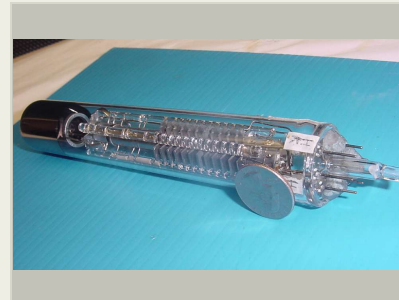
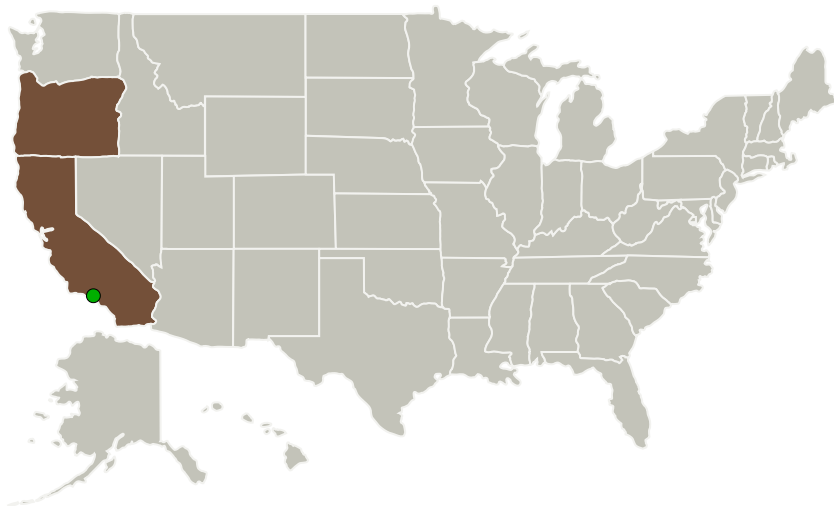
Completed Technology Project (2017 - 2019)



## Project Introduction

We offer an ultra-compact klystron amplifier for remote sensing on CubeSats. It will operate at 35.7 GHz, have 400 MHz bandwidth, and output greater than 32 watts with 35 dB gain. It employs a two-stage depressed collector, allowing prime efficiency of 50%. Comparable solid state power amplifiers have 15% efficiency and output only 7 W. klystrons are the only amplifier technology that can be miniaturized to this degree. Volume with power conditioner and driver is less than 0.500 cm<sup>3</sup>, half the allowed space. It uses a breakthrough ultra-miniature scandate cathode capable of 100A/cm<sup>2</sup> at 1000 degrees C and 5A/cm<sup>2</sup> at less than 800 degrees C. At this temperature, life is more than 100,000 hours. The klystron uses cathode ray tube construction, which lowers weight, size and cost (two to five times less than standard brazed ceramic-metal construction). Parts are fastened via glass rods or mechanical capture or by spot welding. Most parts are standard off-the-shelf, which further lowers cost. It uses a glass vacuum envelope, glass feedthroughs, combination RF window-coupler and barium getters to maintain vacuum. In Phase I we successfully built two beam testers. In Phase II we construct an entire amplifier package in CubeSat volume. E beam, inc. is a leader in innovative miniature cathodes, electron guns and vacuum electron devices generally. It has long promoted cathode ray tube construction as a way to mass produce medium power microwave tubes.

## Primary U.S. Work Locations and Key Partners



Ka-Band Klystron Amplifier for CUBESATs, Phase II Briefing Chart Image

## Table of Contents

Project Introduction	1
Primary U.S. Work Locations and Key Partners	1
Project Transitions	2
Images	2
Organizational Responsibility	2
Project Management	2
Technology Maturity (TRL)	2
Technology Areas	3
Target Destinations	3

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Organizations Performing Work	Role	Type	Location
e-beam, Inc.	Lead Organization	Industry Veteran-Owned Small Business (VOSB)	Beaverton, Oregon
● Jet Propulsion Laboratory(JPL)	Supporting Organization	NASA Center	Pasadena, California

Primary U.S. Work Locations	
California	Oregon

## Project Transitions

▶ **April 2017:** Project Start

✓ **July 2019:** Closed out

**Closeout Documentation:**

- Final Summary Chart(<https://techport.nasa.gov/file/140817>)

## Images

**Briefing Chart Image**

Ka-Band Klystron Amplifier for CUBESATs, Phase II Briefing Chart Image  
(<https://techport.nasa.gov/image/132523>)

**Final Summary Chart Image**

Ka-Band Klystron Amplifier for CUBESATs, Phase II  
(<https://techport.nasa.gov/image/135571>)

## Organizational Responsibility

**Responsible Mission Directorate:**

Space Technology Mission Directorate (STMD)

**Lead Organization:**

e-beam, Inc.

**Responsible Program:**

Small Business Innovation Research/Small Business Tech Transfer

## Project Management

**Program Director:**

Jason L Kessler

**Program Manager:**

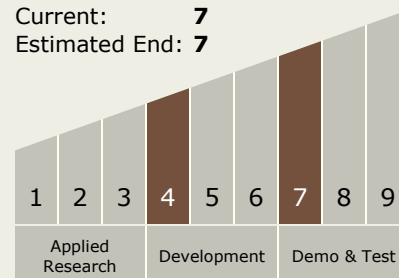
Carlos Torrez

**Principal Investigator:**

Bernard K Vancil

## Technology Maturity (TRL)

Start: 4  
Current: 7  
Estimated End: 7



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### Final Summary Chart Image

Ka-Band Klystron Amplifier for  
CUBESATs, Phase II

(<https://techport.nasa.gov/image/128178>)

## Technology Areas

### Primary:

- TX08 Sensors and Instruments
  - └ TX08.1 Remote Sensing Instruments/Sensors
  - └ TX08.1.4 Microwave, Millimeter-, and Submillimeter-Waves

## Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System